

In the Claims:

Kindly amend the claims as follows:

Kindly cancel claims 1-177 without prejudice.

Claims 1-177 (cancelled).

178. (new) Apparatus for performing mediated electrochemical oxidation (MEO) processes for:

(1)destruction of: a) nearly all organic solid, liquid, and gaseous materials, except fluorinated hydrocarbons; b) all biological solid, liquid, and gaseous materials; c) all inorganic solid, liquid, and gaseous materials, where higher oxidation states exist for at least one element in those compounds; and d) combined materials (e.g. a mixture of any of the foregoing with each other); henceforth collectively referred to as materials;

(2) sterilization/disinfection: a) by destroying all infectious materials; b) by sterilizing of equipment, glassware, etc of infectious materials;

(3) dissolution of transuranic/actinide material and/or destruction of the oxidizable components in the hazardous waste portion of mixed waste;

(4)generation of hydrogen from the cathodic reduction of hydrogen and/or hydronium ions; and

(5)alteration of organic, biological, and inorganic materials by MEO to produce other compounds; comprising an electrochemical cell, an aqueous electrolyte disposed in the electrochemical cell, a semi permeable membrane, ion selective membrane, microporous polymer, porous ceramic or glass frit membrane disposed in the electrochemical cell for separating the cell into anolyte and catholyte chambers and separating the electrolyte into aqueous anolyte and catholyte portions, electrodes further comprising an anode and a

cathode disposed in the electrochemical cell respectively in the anolyte and catholyte chambers and in the anolyte and catholyte portions of the electrolyte; a power supply connected to the anode and the cathode for applying a direct current voltage between the anolyte and the catholyte portions of the electrolyte; and treating and oxidizing the aforementioned materials in the anolyte portion with a mediated electrochemical oxidation (MEO) process, wherein the anolyte portion further comprises oxidizing species as a mediator in aqueous solution and the electrolyte is an acid, neutral or alkaline aqueous solution, and wherein the mediator oxidizing species are simple anion redox couples described in Table I as below; Type I isopolyanions complex anion redox couples formed by incorporation of Mo, W, V, Nb, Ta, or mixtures thereof as addenda atoms; Type I heteropolyanions complex anion redox couples formed by incorporation into Type I isopolyanions as heteroatoms any of the elements listed in Table II either singly or in combination thereof, or heteropolyanions complex anion redox couples containing at least one heteroatom type element contained in both Table I and Table II below or combinations of the mediator oxidizing species from any or all of these generic groups:

1.

Table I: Simple Anion Redox Couples

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
I	A	None			
	B	Copper (Cu)	+2	Cu <sup>+2</sup> (cupric) HCuO <sub>2</sub> (bicuprite) CuO <sub>2</sub> <sup>-2</sup> (cuprite)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
			+3	Cu <sup>+3</sup> CuO <sub>2</sub> <sup>-</sup> (cuprate) Cu <sub>2</sub> O <sub>3</sub> (sesquioxide)	
			+4	CuO <sub>2</sub> (peroxide)	
		Silver (Ag)	+1	Ag <sup>+</sup> (argentous) AgO <sup>-</sup> (argentite)	+1 Species/ +2, +3 Species; +2 Species/ +3 Species
			+2	Ag <sup>+2</sup> (argentic) AgO (argentic oxide)	
			+3	AgO <sup>+</sup> (argetyl) Ag <sub>2</sub> O <sub>3</sub> (sesquioxide)	
		Gold (Au)	+1	Au <sup>+</sup> (aurous)	+1 Species/ +3, +4 Species; + 3 Species/ +4 Species
			+3	Au <sup>+3</sup> (auric) AuO <sup>-</sup> (auryl) H <sub>3</sub> AuO <sub>3</sub> <sup>-</sup> (auric acid) H <sub>2</sub> AuO <sub>3</sub> <sup>-</sup> (monoaaurate) HAuO <sub>3</sub> <sup>-2</sup> (diaurate) AuO <sub>3</sub> <sup>-3</sup> (triaurate) Au <sub>2</sub> O <sub>3</sub> (auric oxide) Au(OH) <sub>3</sub> (auric hydroxide)	
			+4	AuO <sub>2</sub> (peroxide)	
II	A	Magnesium (Mg)	+2	Mg <sup>+2</sup> (magnestic)	+2 Species/ +4 Species
			+4	MgO <sub>2</sub> (peroxide)	
		Calcium (Ca)	+2	Ca <sup>+2</sup>	+2 Species/ +4 Species
			+4	CaO <sub>2</sub> (peroxide)	
		Strontium	+2	Sr <sup>+2</sup>	+2 Species/ +4 Species
			+4	SrO <sub>2</sub> (peroxide)	
		Barium (Ba)	+2	Ba <sup>+2</sup>	+2 Species/ +4 Species
			+4	BaO <sub>2</sub> (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES		
II	B	Zinc (Zn)	+2	Zn <sup>+2</sup> (zincic)  ZnOH <sup>+</sup> (zincyl) HZnO <sub>2</sub> <sup>-</sup> (bizincate) ZnO <sub>2</sub> <sup>-2</sup> (zincate)	+2 Species/ +4 Species		
			+4	ZnO <sub>2</sub> (peroxide)			
			Mercury (Hg)	+2		Hg <sup>+2</sup> (mercuric)  Hg (OH) <sub>2</sub> (mercuric hydroxide) HHgO <sub>2</sub> <sup>-</sup> (mercuroate)	+2 Species/ +4 Species
		+4		HgO <sub>2</sub> (peroxide)			
		III		A	Boron	+3	
			+4.5			B <sub>2</sub> O <sub>5</sub> <sup>-</sup> (diborate)	
+5	BO <sub>3</sub> <sup>-</sup> /BO <sub>2</sub> <sup>-</sup> •H <sub>2</sub> O (perborate)						
Thallium (Tl)	+1	Tl <sup>+1</sup> (thallous)	+1 Species/ +3 or +3.33 Species; +3 Species/ +3.33 Species				
	+3	Tl <sup>+3</sup> (thallic)  TlO <sup>+</sup> , TlOH <sup>+2</sup> , Tl(OH) <sub>2</sub> <sup>+</sup> (thallyl) Tl <sub>2</sub> O <sub>3</sub> (sesquioxide) Tl(OH) <sub>3</sub> (hydroxide)					
		+3.33				Tl <sub>3</sub> O <sub>5</sub> (peroxide)	
		B			See Rare Earths and Actinides		

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IV	A	Carbon (C)	+4	H <sub>2</sub> CO <sub>3</sub> (carbonic acid) HCO <sub>3</sub> <sup>-</sup> (bicarbonate) CO <sub>3</sub> <sup>-2</sup> (carbonate)	+4 Species/ +5, +6 Species
			+5	H <sub>2</sub> C <sub>2</sub> O <sub>6</sub> (perdicarbonic acid)	
			+6	H <sub>2</sub> CO <sub>4</sub> (permonocarbonic acid)	
		Germanium (Ge)	+4	H <sub>2</sub> GeO <sub>3</sub> (germanic acid) HGeO <sub>3</sub> <sup>-</sup> (bigermaniate) GeO <sub>3</sub> <sup>-4</sup> (germinate) Ge <sup>+4</sup> (germanic) GeO <sub>4</sub> <sup>-4</sup> H <sub>2</sub> Ge <sub>2</sub> O <sub>5</sub> (digermanic acid) H <sub>2</sub> Ge <sub>4</sub> O <sub>9</sub> (tetragermanic acid) H <sub>2</sub> Ge <sub>5</sub> O <sub>11</sub> (pentagermanic acid) HGe <sub>5</sub> O <sub>11</sub> <sup>-</sup> (bipentagermanate)	+4 Species/ +6 Species
			+6	Ge <sub>5</sub> O <sub>11</sub> <sup>-2</sup> (pentagermanate)	
		Tin (Sn)	+4	Sn <sup>+4</sup> (stannic) HSnO <sub>3</sub> <sup>-</sup> (bistannate) SnO <sub>3</sub> <sup>-2</sup> (stannate) SnO <sub>2</sub> (stannic oxide) Sn(OH) <sub>4</sub> (stannic hydroxide)	+4 Species/ +7 Species
			+7	SnO <sub>4</sub> <sup>-</sup> (perstannate)	
		Lead (Pb)	+2	Pb <sup>+2</sup> (plumbous) HPbO <sub>2</sub> <sup>-</sup> (biplumbite) PbOH <sup>+</sup> PbO <sub>2</sub> <sup>-2</sup> (plumbite) PbO (plumbus oxide)	+2, +2.67, +3 Species/+4 Species
				Pb <sub>3</sub> O <sub>4</sub> (plumbo-plumbic oxide)	
				Pb <sub>2</sub> O <sub>3</sub> (sequioxide)	
			+3		
IV	A	Lead (Pb)	+4	Pb <sup>+4</sup> (plumbic)	+2, +2.67, +3 Species/+4 Species
				PbO <sub>3</sub> <sup>-2</sup> (metaplumbate)	
				HPbO <sub>3</sub> <sup>-</sup> (acid metaplumbate)	
				PbO <sub>4</sub> <sup>-4</sup> (orthoplumbate)	
				PbO <sub>2</sub> (dioxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IV	B	Titanium	+4	TiO <sup>+2</sup> (pertitanyl) HTiO <sub>4</sub> <sup>-</sup> titanate) TiO <sub>2</sub> (dioxide)	+4 Species/ +6 Species
			+6	TiO <sub>2</sub> <sup>+2</sup> (pertitanyl) HTiO <sub>4</sub> <sup>-</sup> (acid pertitanate) TiO <sub>4</sub> <sup>-2</sup> (pertitanate) TiO <sub>3</sub> (peroxide)	
		Zirconium (Zr)	+4	Zr <sup>+4</sup> (zirconic) ZrO <sup>+2</sup> (zirconyl) HZrO <sub>3</sub> <sup>-</sup> (zirconate)	+4 Species/ +5, +6, +7 Species
			+5	Zr <sub>2</sub> O <sub>5</sub> (pentoxide)	
			+6	ZrO <sub>3</sub> (peroxide)	
			+7	Zr <sub>2</sub> O <sub>7</sub> (heptoxide)	
		Hafnium (Hf)	+4	Hf <sup>+4</sup> (hafnic) HfO <sup>+2</sup> (hafnyl)	+4 Species/ +6 Species
			+6	HfO <sub>3</sub> (peroxide)	
V	A	Nitrogen	+5	HNO <sub>3</sub> (nitric acid) NO <sub>3</sub> <sup>-</sup> (nitrate)	+5 species/ +7 Species
			+7	HNO <sub>4</sub> (pernitric acid)	
		Phosphorus (P)	+5	H <sub>3</sub> PO <sub>4</sub> (orthophosphoric acid) H <sub>2</sub> PO <sub>4</sub> <sup>-</sup> (monoorthophosphate) HPO <sub>4</sub> <sup>-2</sup> (diorthophosphate) PO <sub>4</sub> <sup>-3</sup> (triorthophosphate) HPO <sub>3</sub> (metaphosphoric acid) H <sub>4</sub> P <sub>2</sub> O <sub>7</sub> (pyrophosphoric acid) H <sub>5</sub> P <sub>3</sub> O <sub>10</sub> (triphosphoric acid) H <sub>6</sub> P <sub>4</sub> O <sub>13</sub> (tetraphosphoric acid)	+5 Species/ +6, +7 species
V	A	Phosphorus (P)	+6	H <sub>4</sub> P <sub>2</sub> O <sub>8</sub> (perphosphoric acid)	+5 Species/ +6, +7 Species
			+7	H <sub>3</sub> PO <sub>5</sub> (monoperphosphoric acid)	

GROUP	SUB-GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
V	A	Arsenic (As)	+5	H <sub>3</sub> AsO <sub>4</sub> (ortho-arsenic acid) H <sub>2</sub> AsO <sub>4</sub> <sup>-</sup> (mono ortho-arsenate) HAsO <sub>4</sub> <sup>-2</sup> (di-ortho-arsenate) AsO <sub>4</sub> <sup>-3</sup> (tri-ortho-arsenate) AsO <sub>2</sub> <sup>+</sup> (arsenyl)	+5 Species/ +7 species
			+7	AsO <sub>3</sub> <sup>+</sup> (perarsenyl)	
		Bismuth (Bi)	+3	Bi <sup>+3</sup> (bismuthous)  BiOH <sup>+2</sup> (hydroxybismuthous) BiO <sup>+</sup> (bismuthyl) BiO <sub>2</sub> <sup>-</sup> (metabismuthite)	+3 Species/ +3.5, +4, +5 Species
			+3.5	Bi <sub>4</sub> O <sub>7</sub> (oxide)	
			+4	Bi <sub>2</sub> O <sub>4</sub> (tetroxide)	
			+5	BiO <sub>3</sub> <sup>-</sup> (metabismuthite) Bi <sub>2</sub> O <sub>5</sub> (pentoxide)	
	B	Vanadium (V)	+5	VO <sub>2</sub> <sup>+</sup> (vanadic)  H <sub>3</sub> V <sub>2</sub> O <sub>7</sub> <sup>-</sup> (pyrovanadate) H <sub>2</sub> VO <sub>4</sub> <sup>-</sup> (orthovanadate) VO <sub>3</sub> <sup>-</sup> (metavanadate) HVO <sub>4</sub> <sup>-2</sup> (orthovanadate) VO <sub>4</sub> <sup>-3</sup> (orthovanadate) V <sub>2</sub> O <sub>5</sub> (pentoxide) H <sub>4</sub> V <sub>2</sub> O <sub>7</sub> (pyrovanadic acid) HVO <sub>3</sub> (metavanadic acid) H <sub>4</sub> V <sub>6</sub> O <sub>17</sub> (hexavanadic acid)	+5 Species/ +7, +9 Species
			+7	VO <sub>4</sub> <sup>-</sup> (pervanadate)	
			+9	VO <sub>5</sub> <sup>-</sup> (hypervanadate)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES		
V	B	Niobium (Nb)	+5	NbO <sub>3</sub> <sup>-</sup> (metaniobate)  NbO <sub>4</sub> <sup>-3</sup> (orthoniobate) Nb <sub>2</sub> O <sub>5</sub> (pentoxide) HNbO <sub>3</sub> (niobid acid)	+5 Species/ +7 species		
			+7	NbO <sub>4</sub> <sup>-</sup> (perniobate) Nb <sub>2</sub> O <sub>7</sub> (perniobic oxide) HNbO <sub>4</sub> (perniobic acid)			
		Tantalum (Ta)	+5	TaO <sub>3</sub> <sup>-</sup> (metatantalate)  TaO <sub>4</sub> <sup>-3</sup> (orthotantalate) Ta <sub>2</sub> O <sub>5</sub> (pentoxide) HTaO <sub>3</sub> (tantalic acid)	+5 species/ +7 species		
			+7	TaO <sub>4</sub> <sup>-</sup> (pentantalate) Ta <sub>2</sub> O <sub>7</sub> (pertantalate) HTaO <sub>4</sub> •H <sub>2</sub> O (pertantalic acid)			
		VI	A	Sulfur (S)	+6	H <sub>2</sub> SO <sub>4</sub> (sulfuric acid)  HSO <sub>4</sub> <sup>-</sup> (bisulfate) SO <sub>4</sub> <sup>-2</sup> (sulfate)	+6 Species/ +7, +8 Species
					+7	S <sub>2</sub> O <sub>8</sub> <sup>-2</sup> (dipersulfate)	
+8	H <sub>2</sub> SO <sub>5</sub> (momopersulfuric acid)						
Selenium (Se)	+6			H <sub>2</sub> Se <sub>2</sub> O <sub>4</sub> (selenic acid)  HSeO <sub>4</sub> <sup>-</sup> (biselenate) SeO <sub>4</sub> <sup>-2</sup> (selenate)	+6 species/ +7 Species		
	+7			H <sub>2</sub> Se <sub>2</sub> O <sub>8</sub> (perdiselenic acid)			
Tellurium (Te)	+6			H <sub>2</sub> TeO <sub>4</sub> (telluric acid)  HTeO <sub>4</sub> <sup>-</sup> (bitellurate) TeO <sub>4</sub> <sup>-2</sup> (tellurate)	+6 species/ +7 species		
	+7	H <sub>2</sub> Te <sub>2</sub> O <sub>8</sub> (perditellenic acid)					
		Polonium (Po)	+2	Po <sup>+2</sup> (polonous)	+2, +4 species/ +6 Species		
			+4	PoO <sub>3</sub> <sup>-2</sup> (polonate)			
			+6	PoO <sub>3</sub> (peroxide)			



GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VI	B	Chromium	+3	$\text{Cr}^{+3}$ (chromic) $\text{CrOH}^{+2}$ , $\text{Cr(OH)}_2^+$ (chromyls) $\text{CrO}_2^-$ , $\text{CrO}_3^{-3}$ (chromites) $\text{Cr}_2\text{O}_3$ (chromic oxide) $\text{Cr(OH)}_3$ (chromic hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	$\text{CrO}_2$ (dioxide) $\text{Cr(OH)}_4$ (hydroxide)	
			+6	$\text{H}_2\text{CrO}_4$ (chromic acid) $\text{HCrO}_4^-$ (acid chromate) $\text{CrO}_4^{-2}$ (chromate) $\text{Cr}_2\text{O}_7^{-2}$ (dichromate)	
		Molybdenum (Mo)	+6	$\text{HMoO}_4^-$ (bimolybdate) $\text{MoO}_4^{-2}$ (molybdate) $\text{MoO}_3$ (molybdic trioxide) $\text{H}_2\text{MoO}_4$ (molybolic acid)	+6 Species/ +7 Species
			+7	$\text{MoO}_4^-$ (permolybdate)	
		Tungsten (W)	+6	$\text{WO}_4^{-2}$ tungstic) $\text{WO}_3$ (trioxide) $\text{H}_2\text{WO}_4$ (tungstic acid)	+6 Species/ +8 Species
			+8	$\text{WO}_5^{-2}$ (pertungstic) $\text{H}_2\text{WO}_5$ (pertungstic acid)	
VII	A	Chlorine (Cl)	+1	$\text{HClO}$ (hypochlorous acid) $\text{ClO}^-$ (hypochlorite)	+1 Species/ +3, +5, +7 Species; +3 Species/ +5, +7 Species; +5 Species/ +7 Species
			+3	$\text{HClO}_2$ (chlorous acid) $\text{ClO}_2^-$ (chlorite)	
			+5	$\text{HClO}_3$ (chloric acid) $\text{ClO}_3^-$ (chlorate)	
			+7	$\text{HClO}_4$ (perchloric acid) $\text{ClO}_4^-$ , $\text{HClO}_5^{-2}$ , $\text{ClO}_5^{-3}$ , $\text{Cl}_2\text{O}_9^{-4}$ (perchlorates)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VII	A	Bromine (Br)	+1	HBrO (hypobromous acid) BrO <sup>-</sup> (hypobromite)	+1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; +5 Species/ +7 Species
			+3	HBrO <sub>2</sub> (bromous acid) BrO <sub>2</sub> <sup>-</sup> (bromite)	
			+5	HBrO <sub>3</sub> (bromic acid) BrO <sub>3</sub> <sup>-</sup> (bromate)	
			+7	HBrO <sub>4</sub> (perbromic acid) BrO <sub>4</sub> <sup>-</sup> , HBrO <sub>5</sub> <sup>-2</sup> , BrO <sub>5</sub> <sup>-3</sup> , Br <sub>2</sub> O <sub>9</sub> <sup>-4</sup> (prebromates)	
		Iodine	+1	HIO (hypoiodous acid) IO <sup>-</sup> (hypoiodite)	+1 Species/+3, +5, +7 Species; +3 Species/ +5, +7 Species; +5 Species/ +7 Species
			+3	HIO <sub>2</sub> (iodous acid) IO <sub>2</sub> <sup>-</sup> (iodite)	
			+5	HIO <sub>3</sub> (iodic acid) IO <sub>3</sub> <sup>-</sup> (iodate)	
			+7	HIO <sub>4</sub> (periodic acid) IO <sub>4</sub> <sup>-</sup> , HIO <sub>5</sub> <sup>-2</sup> , IO <sub>5</sub> <sup>-3</sup> , I <sub>2</sub> O <sub>9</sub> <sup>-4</sup> (periodates)	
	B	Manganese (Mn)	+2	Mn <sup>+2</sup> (manganeous) HMnO <sub>2</sub> <sup>-</sup> (dimanganite)	+2 Species/ +3, +4, +6, +7 Species; +3 Species/ +4, +6, +7 Species; +4 Species/ +6, +7 Species; +6 Species/ +7 Species
			+3	Mn <sup>+3</sup> (manganic)	
			+4	MnO <sub>2</sub> (dioxide)	
			+6	MnO <sub>4</sub> <sup>-2</sup> (manganate)	
			+7	MnO <sub>4</sub> <sup>-</sup> (permanganate)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 4	Iron (Fe)	+3	Fe <sup>+3</sup> (ferric) Fe(OH) <sup>+2</sup> Fe(OH) <sub>2</sub> <sup>+</sup> FeO <sub>2</sub> <sup>-2</sup> (ferrite)	+3 Species/+4, +5, +6 Species;
VIII	Period 4	Iron (Fe)	+4	FeO <sup>+2</sup> (ferryl)  FeO <sub>2</sub> <sup>-2</sup> (perferrite)	+4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+5	FeO <sub>2</sub> <sup>+</sup> (perferryl)	
			+6	FeO <sub>4</sub> <sup>-2</sup> (ferrate)	
		Cobalt (Co)	+2	Co <sup>+2</sup> (cobalous)  HCoO <sub>2</sub> <sup>-</sup> (dicobaltite)	+2 Species/ +3, +4 Species; +3 Species/ +4 Species
			+3	Co <sup>+3</sup> (cobaltic) Co <sub>2</sub> O <sub>3</sub> (cobaltic oxide)	
			+4	CoO <sub>2</sub> (peroxide) H <sub>2</sub> CoO <sub>3</sub> (cobaltic acid)	
		Nickel (Ni)	+2	Ni <sup>+2</sup> (nickelous)  NiOH <sup>+</sup>  HNiO <sub>2</sub> <sup>-</sup> (dinickelite)  NiO <sub>2</sub> <sup>-2</sup> (nickelite)	+2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	Ni <sup>+3</sup> (nickelic) Ni <sub>2</sub> O <sub>3</sub> (nickelic oxide)	
			+4	NiO <sub>2</sub> (peroxide)	
			+6	NiO <sub>4</sub> <sup>-2</sup> (nickelate)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 5	Ruthenium (Ru)	+2	$\text{Ru}^{+2}$	+2 Species/ +3, +4, +5, +6, +7, +8 Species; +3 Species/ +4, +5, +6, +7, +8 Species; +4 Species/ +5, +6, +7, +8 Species; +5 Species/ +6, +7, +8 Species; +6 Species/ +7, +8 Species; +7 Species/ +8 Species
			+3	$\text{Ru}^{+3}$  $\text{Ru}_2\text{O}_3$ (sesquioxide)  $\text{Ru}(\text{OH})_3$ (hydroxide)	
			+4	$\text{Ru}^{+4}$ (ruthenic)  $\text{RuO}_2$ (ruthenic dioxide)  $\text{Ru}(\text{OH})_4$ (ruthenic hydroxide)	
			+5	$\text{Ru}_2\text{O}_5$ (pentoxide)	
			+6	$\text{RuO}_4^{-2}$ (ruthenate) $\text{RuO}_2^{+2}$ (ruthenyl) $\text{RuO}_3$ (trioxide)	
			+7	$\text{RuO}_4^-$ (perruthenate)	
			+8	$\text{H}_2\text{RuO}_4$ (hyperuthenic acid) $\text{HRuO}_5^-$ (diperruthenate) $\text{RuO}_4$ (ruthenium tetroxide)	
		Rhodium (Rh)	+1	$\text{Rh}^+$ (hyporhodous)	+1 Species/ +2, +3, +4, +6 Species; +2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+2	$\text{Rh}^{+2}$ (rhodous)	
			+3	$\text{Rh}^{+3}$ (rhodic)  $\text{Rh}_2\text{O}_3$ (sesquioxide)	
			+4	$\text{RhO}_2$ (rhodic oxide) $\text{Rh}(\text{OH})_4$ (hydroxide)	
			+6	$\text{RhO}_4^{-2}$ (rhodate) $\text{RhO}_3$ (trioxide)	
		Palladium	+2	$\text{Pd}^{+2}$ (palladous)  $\text{PdO}_2^{-2}$ (palladite)	+2 Species/ +3, +4, +6 Species; +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	$\text{Pd}_2\text{O}_3$ (sesquioxide)	
			+4	$\text{Pd O}_3^{-2}$ (palladate) $\text{PdO}_2$ (dioxide) $\text{Pd}(\text{OH})_4$ (hydroxide)	
			+6	$\text{PdO}_3$ (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
VIII	Period 6	Iridium (Ir)	+3	Ir <sup>+3</sup> (iridic) Ir <sub>2</sub> O <sub>3</sub> (iridium sesquioxide) Ir (OH) <sub>3</sub> (iridium hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	IrO <sub>2</sub> (iridic oxide) Ir (OH) <sub>4</sub> (iridic hydroxide)	
			+6	IrO <sub>4</sub> <sup>-2</sup> (iridate) IrO <sub>3</sub> (iridium peroxide)	
		Platinum (Pt)	+2	Pt <sup>+2</sup> (platinous)	+2, +3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+3	Pt <sub>2</sub> O <sub>3</sub> (sesquioxide)	
			+4	PtO <sub>3</sub> <sup>-2</sup> (palatinate) PtO <sup>+2</sup> (platynyl) Pt(OH) <sup>+3</sup> PtO <sub>2</sub> (platonic oxide)	
			+6	PtO <sub>4</sub> <sup>-2</sup> (Perplatinate) PtO <sub>3</sub> (perplatonic oxide)	
		Cerium (Ce)	+3	Ce <sup>+3</sup> (cerous) Ce <sub>2</sub> O <sub>3</sub> (cerous oxide) Ce(OH) <sub>3</sub> (cerous hydroxide)	+3 Species/ +4, +6 Species; +4 Species/ +6 Species
			+4	Ce <sup>+4</sup> , Ce(OH) <sup>+3</sup> , Ce(OH) <sub>2</sub> <sup>+2</sup> , Ce(OH) <sub>3</sub> <sup>+</sup> (ceric) CeO <sub>2</sub> (ceric oxide)	
			+6	CeO <sub>3</sub> (peroxide)	
IIIB	Rare earths	Praseodymium (Pr)	+3	Pr <sup>+3</sup> (praseodymous) Pr <sub>2</sub> O <sub>3</sub> (sesquioxide) Pr(OH) <sub>3</sub> (hydroxide)	+3 species/ +4 species
			+4	Pr <sup>+4</sup> (praseodymic) PrO <sub>2</sub> (dioxide)	
		Neodymium	+3	Nd <sup>+3</sup> Nd <sub>2</sub> O <sub>3</sub> (sesquioxide)	+3 Species/ +4 Species
			+4	NdO <sub>2</sub> (peroxide)	
		Terbium (Tb)	+3	Tb <sup>+3</sup> Tb <sub>2</sub> O <sub>3</sub> (sesquioxide)	+3 Species/ +4 Species
			+4	TbO <sub>2</sub> (peroxide)	

GROUP	SUB GROUP	ELEMENT	VALENCE	SPECIES	SPECIFIC REDOX COUPLES
IIIB	Actinides	Thorium (Th)	+4	Th <sup>+4</sup> (thoric) ThO <sup>+2</sup> (thoryl) HThO <sub>3</sub> <sup>-</sup> (thorate)	+4 Species/ +6 Species
			+6	ThO <sub>3</sub> (acid peroxide)	
		Uranium (U)	+6	UO <sub>2</sub> <sup>+2</sup> (uranyl) UO <sub>3</sub> (uranic oxide)	+6 Species/ +8 Species
			+8	HUO <sub>5</sub> <sup>-</sup> , UO <sub>5</sub> <sup>-2</sup> (peruranates) UO <sub>4</sub> (peroxide)	
		Neptunium (Np)	+5	NpO <sub>2</sub> <sup>+</sup> (hyponeptunyl) Np <sub>2</sub> O <sub>5</sub> (pentoxide)	+5 Species/ +6, +8 Species; +6 Species/ +8 Species
			+6	NpO <sub>2</sub> <sup>+2</sup> (neptunyl) NpO <sub>3</sub> (trioxide)	
			+8	NpO <sub>4</sub> (peroxide)	
		Plutonium (Pu)	+3	Pu <sup>+3</sup> (hypoplutinous)	+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+4	Pu <sup>+4</sup> (plutinous) PuO <sub>2</sub> (dioxide)	
			+5	PuO <sub>2</sub> <sup>+</sup> (hypoplutonyl) Pu <sub>2</sub> O <sub>5</sub> (pentoxide)	
			+6	PuO <sub>2</sub> <sup>+2</sup> (plutonyl) PuO <sub>3</sub> (peroxide)	
		Americium (Am)	+3	Am <sup>+3</sup> (hypoamericious)	+3 Species/ +4, +5, +6 Species; +4 Species/ +5, +6 Species; +5 Species/ +6 Species
			+4	Am <sup>+4</sup> (americous) AmO <sub>2</sub> (dioxide) Am(OH) <sub>4</sub> (hydroxide)	
			+5	AmO <sub>2</sub> <sup>+</sup> (hypoamericyl) Am <sub>2</sub> O <sub>5</sub> (pentoxide)	
			+6	AmO <sub>2</sub> <sup>+2</sup> (americyl) AmO <sub>3</sub> (peroxide)	

Table II: Elements Participating as Heteroatoms in Heteropolyanion Complex Anion Redox Couple Mediators

GROUP	SUB GROUP	ELEMENT
I	A	Lithium (Li), Sodium (Na), Potassium (K), and Cesium (Cs)
	B	Copper (Cu), Silver (Ag), and Gold (Au)
II	A	Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), and Barium (Ba)
	B	Zinc (Zn), Cadmium (Cd), and Mercury (Hg)
III	A	Boron (B), and Aluminum (Al)
	B	Scandium (Sc), and Yttrium (Y) – (See Rare Earths)
IV	A	Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb)
	B	Titanium (Ti), Zirconium (Zr), and Hafnium (Hf)
V	A	Nitrogen (N), Phosphorous (P), Arsenic (As), Antimony (Sb), and Bismuth (Bi)
	B	Vanadium (V), Niobium (Nb), and Tantalum (Ta)
VI	A	Sulfur (S), Selenium (Se), and Tellurium (Te)
	B	Chromium (Cr), Molybdenum (Mo), and Tungsten (W)
VII	A	Fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I)
	B	Manganese (Mn), Technetium (Tc), and Rhenium (Re)
VIII	Period 4	Iron (Fe), Cobalt (Co), and Nickel (Ni)
	Period 5	Ruthenium (Ru), Rhodium (Rh), and Palladium (Pd)
	Period 6	Osmium (Os), Iridium (Ir), and Platinum (Pt)
IIIB	Rare Earths	All

179. (new) The apparatus of claim 178, further comprising an electrochemical cell including plural closed-loop systems, electrolytes in the closed-loop systems, and pumps coupled to the closed-loop systems for circulating the electrolytes in each of the plural systems, a membrane for separating the plural closed-loop systems into anolyte chamber and catholyte chamber in the cell permitting a user to change the electrolytes without altering the apparatus, comprising a drain in each of the closed-loop systems for separately removing and/or replacing the anolyte and/or the catholyte in the apparatus.

180. (new) The apparatus of claim 178, further comprising an anolyte system wherein all surfaces of the apparatus in contact with the anolyte comprise one or more of the types of materials selected from the group consisting of nonreactive polymers, stainless steel coated with nonreactive polymers, glass, PTFE coated metallic tubing, glazed ceramics, glazed metallics, glazed composites,

and combinations thereof, anolyte reaction chamber; an input pump to enter anolyte into the anolyte reaction chamber includes

(1) spray and/or stream head(s) for introducing the anolyte into the anolyte chamber for increasing exposure of the materials to the anolyte by enhancing the mixing in the anolyte chamber and promoting contact with any immiscible materials present in surface layers,

(2) enhancing devices for enhancing contact of the oxidizing species with solid or liquid immiscible liquid materials, or incomplete oxidation products that are solid, immiscible liquid, or gaseous at the conditions within the anolyte chamber; wherein, the anolyte comprises an aqueous solution of mediator species and electrolytes appropriate for the species, the electrolyte is selected from the group consisting of acid, alkaline, neutral salts, and combinations thereof.

181. (new) The apparatus of claim 178, further comprising an anolyte temperature control system, wherein the temperature is along a range at or below an operating temperature to a maximum desired operating temperature corresponding to a rate of destruction of materials and/or the order in which specific molecular bonds are broken, the temperature range is approximately slightly above 0°C to slightly below the boiling point of the anolyte solution or slightly below 100°C, the temperature of the anolyte chamber is most conducive to the desired materials destruction rate while the temperature of the electrochemical cell can be operated at the temperature most conducive to oxidizer formation, comprising heaters coupled to the chambers for heating the anolyte, comprising chillers coupled to the chambers for cooling the anolyte.

182. (new) The apparatus of claim 178, further comprising anolyte energy sources coupled to the cell for providing ultrasonic and ultraviolet energy to the anolyte, ultraviolet source introduced into the anolyte chamber to decompose hydrogen peroxide formed by the MEO process into free hydroxyl radicals.



183. (new) The apparatus of claim 178, further comprising an anolyte gas cleaning system for processing anolyte off-gas, and anolyte return for returning the anolyte to the anolyte pump in the anolyte system and the electrochemical cell where the oxidizing species are regenerated completing circulation in the anolyte system.

184. (new) The apparatus of claim 178, further comprising an anolyte chamber with lid, and includes

- (1) an anolyte reservoir coupled to the anolyte chamber,
- (2) a dump valve for connecting the anolyte reservoir to the anolyte chamber,
- (3) dump valve connecting the anolyte chamber and the anolyte reservoir allowing for the anolyte and contents of the anolyte reaction chamber to be stored in the anolyte reservoir, wherein anytime the lid to the anolyte chamber is opened for access, the dump valve is opened prior to opening the lid such that the liquid contents of the anolyte chamber drops into the anolyte reservoir thereby avoiding potential contact of the anolyte with the user, a waste basket to hold solids in the anolyte chamber; input pump for introducing materials in continuous feed operations into the anolyte chamber and wherein the input pump is connected to a source of the materials to be destroyed, the materials are pumped into the chamber which contains the anolyte used to destroy these materials, and the apparatus continuously circulates the anolyte solution directly from the electrochemical cell through inlet tube into the anolyte chamber to maximize the concentration of oxidizing species contacting the materials includes

- (1) a filter located at the base of the anolyte chamber to limit the size of the solid particles flowing from anolyte chamber thereby preventing solid particles large enough to interfere with the flow in the electrochemical cell from exiting the anolyte chamber,

- (2) a lever connected to the anolyte chamber lid for lowering the basket into the anolyte when the lid and the waste basket are closed such that all of the basket's contents are held submerged in the

anolyte throughout the MEO process,

(3) a seal around the opening of the anolyte chamber lid,

(4) gaseous material supply system connected to the anolyte chamber for supplying gaseous materials in continuous feed operations, wherein the gaseous materials to be processed are pumped from the gaseous material supply into a pressure vessel,

(5) a regulator on the pressure vessel for controlling release of the materials into the anolyte chamber which contains the anolyte for destroying the gaseous materials, comprising bubble heads for introducing the gaseous materials into the anolyte chamber assuring that the gas entering the gas stream is in the form of small bubbles to create a large surface area on which the anolyte acts to oxidize the gaseous materials, the gaseous materials contact the anolyte in a counter current flow and wherein the gaseous materials are introduced into a lower portion of the anolyte chamber through the gaseous materials supply system, further wherein a stream of freshly oxidized anolyte solution directly from the electrochemical cell is introduced into the upper portion of the anolyte reaction chamber through an inlet tube enabling the gaseous materials to continuously react with oxidizing mediator species in the anolyte as the gas rises up in the anolyte chamber past the downward flowing anolyte and wherein the gaseous materials reaching a top of the anolyte chamber has the lowest concentration of oxidizable species and is also in contact with the anolyte having highest concentrations of oxidizer species,

(6) comprising baffles in the anolyte chamber for regulating progress of the gaseous materials through the anolyte in the anolyte chamber,

(7) liquefier for emulsifying the materials introduced into the anolyte chamber thereby greatly increasing the area of contact between the materials and oxidizers during the electrochemical process and increasing the materials destruction rate,

(8) injector for injecting new anolyte into the anolyte chamber if and as required.

185. (new) The apparatus of claim 178, further comprising a removal system for removing any oxidized insoluble compounds in the anolyte that form as a result of mediator or electrolyte ions reacting with anions of or containing halogens, sulfur, phosphorous, nitrogen present in the materials stream thus preventing formation of unstable compounds, removing residue of oxidized insoluble compounds out of the removal system during periodic maintenance if necessary, wherein the oxidized insoluble compounds are converted to water-soluble compounds using any one of several chemical or electrochemical processes.

186. (new) The apparatus of claim 178, comprising a catholyte system providing all surfaces of the apparatus in contact with the catholyte of acid and alkaline resistant materials, catholyte reservoir being made from materials selected from the group consisting of metals, metal composites, fiberglass, glass, ceramics, and combinations thereof, surfaces of the catholyte reservoir being coated with materials selected from the group consisting of TEFLON™, glass, metal oxides, ceramic glazes, and combinations thereof, the catholyte enters the catholyte reservoir from a tube connecting the electrochemical cell to the catholyte reservoir and wherein the catholyte exits the catholyte reservoir through a tube connected to the catholyte pump, the electrolyte is selected from the group consisting of acid, alkaline, neutral salts, and combinations of either acids or alkalines and neutral salts thereof.

187. (new) The apparatus of claim 178, further comprising heaters coupled to the catholyte system for heating the catholyte, chiller coupled to the catholyte system for cooling the catholyte, the temperature is along a range at or below an operating temperature to a maximum desired operating, temperature corresponding to a rate of destruction of materials and/or the order in which specific molecular bonds are broken, ultrasonic source for promoting mixing and certain chemical reactions in the catholyte.

188. (new) The apparatus of claim 178, further comprising an air sparge coupled to the catholyte chamber for introducing air into the catholyte chamber below the surface of the catholyte, air

sparge for introducing external air into the catholyte reservoir below the surface of the catholyte to prevent formation of hazardous off-gases by oxidation of the precursors back to the catholyte's stable composition, further comprising an anolyte recovery system for removing mediator oxidizer ions that transferred through the cell membrane to the catholyte electrolyte to maintain process efficiency, cell operability, or if economic worth of the ions necessitates their recovery.

189. (new) The apparatus of claim 178, further comprising a dewatering system, further comprising a dewatering system having reverse osmosis (RO) units comprising a fluoropolymer/copolymer RO Unit having a membrane of a fluoropolymer/copolymer, wherein the fluoropolymer/copolymer membrane is used for dewatering of the anolyte by an RO unit when the oxidizer being used in the MEO apparatus would damage a membrane made from typical RO membrane materials and wherein cleaning of oxidizable material from the fluoropolymer/copolymer membrane is accomplished by the action of the oxidizer in the anolyte solution as it passes through the RO unit, a multipass RO unit for a dewatering unit where the osmotic pressure head is so large that the pressure limit on the RO membranes may be exceeded or the membrane partition factor may be insufficient to affect the required degree of separation in a single stage, wherein the anolyte or catholyte is pumped by pumps through the RO membrane, RO tubes made out of the RO membrane fill insides of the RO membrane housing, and wherein a dilute solution of the electrolyte is used for lowering the osmotic pressure between the anolyte and catholyte, a dilute electrolyte reservoir for storing the dilute electrolyte which is pumped by a second stage anolyte pump or second stage catholyte pump as the tube side liquid enters into a RO membrane multipass housing, osmotic pressure difference between the tube side liquid and the shell side pure water stream allows operation below pressure limits on the RO membrane, static RO unit wherein volume of the anolyte is relatively small and the flow rate through the RO membrane is low per unit area thus requiring greater flow area such that the total volume of the tubes required for this surface area exceeds the total anolyte volume.

190. (new) The apparatus of claim 178, further comprising a dewatering tube for controlling levels of the catholyte by dewatering when levels exceed a set level by flowing the catholyte back through a dewater reject tube, valve for controlling liquid flowing through the dewatering tube for the adding of returned catholyte or rejecting water makeup from a water storage tank, wherein after the discharging process is complete the discharger output valve opens to the RO pump and the discharged anolyte solution is processed through the RO membrane which is enclosed in the RO membrane housing, and wherein anolyte RO pressure is sensed by a pressure sensor, water storage tank for storing pure water and a valve controlling supply of the water as needed to the dilute electrolyte, RO unit rejecting to catholyte wherein the anolyte and the catholyte are similar in composition and the RO membranes tolerate the electrolytes, wherein excess water in the anolyte is rejected into the catholyte through the RO membrane, wherein the RO again uses the anolyte solution pumped by the pump as the tube side fluid in the RO membrane housing, and wherein the catholyte solution is pumped by the pump through the shell side, returning the anolyte and the catholyte leaving the housing to the anolyte and the catholyte chambers, respectively, a valve opened to allow all the anolyte solution to be transferred from anolyte system through pump into the RO system tubes in the RO membrane housing, high pressure pump for pressurization of the RO system , RO reservoir is pressurized to several thousand psi with air or nitrogen from the pressurized vessel and let stand until the dewatering has reached the desired goal, a regulator for controlling pressure in the RO system by releasing the air or nitrogen gas from the pressurized vessel until the desired pressure has been reached in the RO system and for holding that pressure until the dewatering is complete, a regulator for holding the anolyte under pressure in the RO membrane in the housing and/or a nitrogen pressure vessel for holding the catholyte under pressure with the catholyte RO pump, a regulator for controlling pressure in the RO system by releasing the air or nitrogen gas from the pressurized vessel until the desired pressure has been reached in the RO system and for holding that pressure until the dewatering is

complete, storage tank for storing processed water passing through the membrane, wherein the stored water is available to be returned to either the anolyte or the catholyte or to be rejected from the MEO apparatus, a particulate filter for passing the anolyte and/or catholyte solution exiting the apparatus to remove particulate matter, clean water pump coupled to the cell for pumping clean water into the anolyte chamber and/or the catholyte chamber for restoring levels of the catholyte.

191. (new) The apparatus of claim 178, further comprising an osmotic cell wherein the anolyte and the catholyte have properties such that osmotic pressure drives water from anolyte side to catholyte side of the semi-permeable osmotic membrane, wherein the osmosis cell is pressurized on the anolyte side to increase flow and to dewater the anolyte by driving water from the anolyte to the catholyte, an osmotic cell with selected osmotic fluid wherein the catholyte has too low an osmotic pressure difference and the water in the anolyte will not cross the osmotic membrane, and wherein a second osmotic fluid with a higher osmotic pressure is provided to permit water to pass through the membrane, osmotic cell comprises two separate chambers wherein the anolyte and/or the catholyte flow along one side of an osmotic membrane and wherein another side of the osmotic membrane is in contact with an osmotic fluid having an osmotic pressure that allows water in the anolyte or catholyte to cross the osmotic membrane, an osmotic reservoir for storing the osmotic fluid, a pump for pumping the osmotic fluid from the osmotic reservoir through the osmotic cell and back to the osmotic reservoir, osmotic valve for dewatering the anolyte or the catholyte by operating the valve to allow flow into the RO membrane housing containing the RO membranes.

192. (new) The apparatus of claim 178, further comprising a vacuum evaporation unit for removing water from the anolyte and/or catholyte vacuum evaporation, nanofilters for pretreatment of the materials to remove solids and soluble substances from the anolyte feed stream to the evaporator avoiding air-borne infectious release, wherein filtered anolyte and/or catholyte flows into the evaporator, and from the evaporator returns to the anolyte and/or the catholyte chambers and continue

to circulate through the vacuum evaporator unit until excess , water in the solutions are reduced to desired levels, vacuum pump for reducing pressure in the evaporator system to less than a vapor pressure of water in the anolyte and/or catholyte at their respective temperatures, and a condenser connected to the system wherein water evaporates and progresses into the condenser, wherein pressure in the evaporator condenser system is controlled by vapor pressure of water at the condenser temperature.

193. (new) The apparatus of claim 178, further comprising a controller system comprising computing devices including automated programmable logic controllers (PLCs) coupled to pneumatic controls and system sensors for monitoring the process performed by the MEO apparatus, displaying data and status information on a monitor relative to the monitoring, executing operational cycles in the MEO apparatus, providing methodology to change parameters in the MEO process through digital control over system components including flow control of the anolyte and the catholyte, electrochemical cell power, off-gas systems, ultraviolet and ultrasound systems, further wherein the controller system comprises methodology to monitor and change the MEO parameters including numerous mediator and electrolyte combinations, and wherein the controller system maintains a record of operation of the MEO apparatus for post operation analysis using data recorded in the data logger, comprise storing on the PLC default values for typical parameters such as percent pump flow rate, anolyte and catholyte volume capacity, anolyte and catholyte temperatures, valve operation and sequencing, enabling and disabling of RO dewatering, water makeup in the anolyte and catholyte systems, ultrasonic and ultraviolet source operations, off-gas temperatures, and enabling and disabling the data logging, display includes a touch screen monitor for providing an operator of the MEO apparatus with options for running the apparatus, for displaying status of each component in the MEO apparatus based on the information received from the sensors including state of the oxidation process to directly evaluate the data from the sensors on the monitor, and instrumentation processed through a

signal conditioner, for measuring activity of redox couples using an oxidation reduction potential (ORP) sensor located throughout the MEO apparatus, connections for connecting the controller to the internet and to other operators for real-time interactive sensing, analyzing, monitoring, viewing, and controlling all parameters and components of the MEO apparatus, connections are connections to the internet, phone line, cell phone, personal computer (PC), and other media devices, a data logging system for recording sensor data used to assess performance and past use of the system for viewing remotely or on-site, wherein the controller system provides information to diagnose problems associated with the MEO apparatus, comprising microprocessors or multi-position cyclic timer switches.

194. (new) The apparatus of claim 178, further comprising an off-gas system for processing off-gas from the anolyte reaction chamber from complete and incomplete combustion of the material including carbon-dioxide, oxygen from oxidation of water molecules at the anode and possibly small amounts of low molecular weight hydrocarbons from incomplete combustion that are gases at the anolyte operating temperature and pressure, an exhaust for exhausting the off-gas extracted by air flow through the anolyte chamber and catholyte chamber, exhaust fan in the exhaust for drawing ambient air into the anolyte chamber through the anolyte air intake/filter and into the catholyte chamber through the catholyte air intake/filter, anolyte chiller, wherein the anolyte demister is cooled by the anolyte chiller , anolyte demister wherein reaction products resulting from the oxidation in the anolyte system are discharged through the anolyte off-gas exit tube to the anolyte demister, wherein easily condensed products of incomplete oxidation are separated in the anolyte demister from the anolyte off-gas stream and are returned to the anolyte chamber or the anolyte reservoir through an anolyte condensate return tube for further oxidation, a gas cleaning system for reducing non-condensable incomplete oxidation products to acceptable levels for atmospheric release after the anolyte off-gas is contacted in a counter current flow gas scrubbing system in the gas cleaning system, wherein the noncondensables from the



anolyte demister are introduced into the lower portion of the column through a flow distribution system of the gas cleaning system and a small side stream of freshly oxidized anolyte direct from the electrochemical cell is introduced into the upper portion of the column resulting in the gas phase continuously reacting with the oxidizing mediator species as it rises up the column past the down flowing anolyte, catholyte off-gas handling system for drawing ambient air through the catholyte reservoir and through the catholyte off-gas exit tube to a catholyte demister by the exhaust fan, wherein water vapor in the air stream is condensed in the catholyte demister by the coolant from the catholyte chiller and the condensate returns to the catholyte reservoir through the catholyte condensate return tube.

195. (new) The apparatus of claim 178, further comprising a nitrogen gas system comprising a nitrogen gas bottle having a gas valve for opening and closing the nitrogen gas bottle, wherein the gas valve is closed when the nitrogen gas bottle is being removed from the MEO apparatus and when the gas valve is opened a nitrogen pressure regulator controls the nitrogen gas pressure to the nitrogen gas system, and wherein the nitrogen gas pressure regulator is controlled by commands from the PLC, nitrogen gas system is used to purge the catholyte reservoir if hydrogen gas exceeds a two percent level in the off-gas handling system, catholyte reservoir purge regulator which is opened by a command from the PLC allowing nitrogen gas to flow and/or to purge the catholyte reservoir and a catholyte reservoir purge valve closes the catholyte air sparge so that the nitrogen purges the catholyte reservoir.

196. (new) The apparatus of claim 178, further comprising a hydrogen gas system wherein the catholyte solution enters the catholyte reservoir from the electrochemical cell and returns from the catholyte reservoir through the catholyte pump to the catholyte system and hydrogen exits the catholyte reservoir and the amount of hydrogen is detected by a hydrogen gas detector, wherein the hydrogen off-gas passes through a catholyte demister, and chilled coolant flows from a catholyte chiller to the catholyte demister and returns to the catholyte chiller, wherein the hydrogen gas is not collected for

further use and is diluted by air entering the catholyte reservoir through the catholyte air intake filter when the catholyte air intake valve is in the open position, wherein the hydrogen selection valve is positioned by commands from the PLC to exhaust the diluted hydrogen through the exhaust fan to the off-gas vent, wherein the hydrogen gas is collected for use by either a fuel cell system or a combustion system such as a water heater, wherein the catholyte air intake valve is in the closed position, the hydrogen selection valve is in the position to pass the hydrogen gas to hydrogen gas pump which compresses the hydrogen which passes through a hydrogen gas regulator, a hydrogen sensor measures the percentage of hydrogen gas flowing to the hydrogen gas regulator, compressed hydrogen is stored in a pressurized hydrogen storage bottle and hydrogen is released through the hydrogen regulator to devices in use.

197. (new) The apparatus of claim 178, further comprising a discharger comprising two or more electrodes between which the anolyte flow is directed during the discharge process is introduced in the anolyte flow stream, a discharger input valve is opened to allow the anolyte to enter the discharger, and a discharger output valve is opened to permit the flow of the anolyte leaving the discharger to flow through the sensor back to the anolyte chamber, further comprising low voltage AC or DC electro potential applied between adjacent discharger electrodes selected so as to cathodically reduce the oxidizer species present in the anolyte without causing their production via anodic oxidation, wherein the low voltage discharges the oxidizers in the anolyte and the discharger provides electrons to the oxidizers when they are returned to their reduced form, an oxidation reduction potential (ORP) sensor senses the oxidized mediators in the anolyte being discharged which circulates through the discharger until the mediator oxidation potential reaches a pre-determined level.

198. (new) The apparatus of claim 178, further comprising sensors and interlocks which includes;

(1) access door on the anolyte reaction chamber (ARC) interlocked with dump valve that connects

the ARC and anolyte reservoir chamber,

(2) dump valve opens before access door may be opened precluding contact between human operator and anolyte fluid,

(3) surveillance of ARC operation provided by camera directly through transparent of ARC access door,

(4) ultrasonic sensors that measure the amount of anolyte/catholyte fluid in the anolyte/catholyte vessels,

(5) electrolyte leak detector sensor located under the electrochemical cell,

(6) electrolyte leak detector sensor is located within the contain vessel,

(7) compartment housing electrical components kept under positive nitrogen pressure to preclude infiltration of explosive gases into the space,

(8) nitrogen deluge introduced into apparatus confines if hydrogen gas level alarm is triggered,

(9) spark proof motion actuators within hydrogen prone areas that may utilize an independent pneumatic or hydraulic power supply,

(10) monitoring devices for carbon dioxide, oxygen and hydrogen gas,

(11) oxidation reduction potential sensors(ORPs) that measure Redox potential throughout the anolyte and catholyte fluid,

(12) pH sensors measure pH in the catholyte fluid,

(13) sensors that measure pressure, temperature, flow rate throughout the anolyte and catholyte fluid.

199. (new) The apparatus of claim 178, wherein the MEO apparatus is operable in either full automatic or manual modes including waste destruction cycle used for destruction or oxidation process, solids removal cycle used to remove any solid residuals, the ABORT Cycle used to stop the MEO process when necessary, cleaning and disinfection cycle used to sterilize/disinfect objects and

equipment, MANUAL cycle which enables a full diagnostic and data analysis capability, controller may be used to alter or modify the modes of operation without changing the apparatus hardware.

200. (new) The apparatus of claim 178, wherein the sequence of operations of the apparatus is changeable without altering the apparatus hardware, the use of the apparatus is changeable without altering the apparatus hardware, menu of operations may be expanded or modified without disturbing the basic architecture of the controller, controller may store the history of operations of the apparatus for purposes of assisting in maintainability and operability, sequence of operations may be changed temporarily and returned to one of the default sequences, controller may maintain the status of the process during the apparatus operation, based on default values of sensors the controller may alter the operating sequence.

201. (new) The apparatus of claim 178, further comprising inherent safety features includes

(1) automated apparatus operations to assure all requisite operations and safe guards are synchronized with human activity,

(2) all operations of apparatus are interlocked with all others enabling safe and automated operations,

(3) fully instrumentation to signal alarms when any operating parameters (heater/chiller temperatures, anolyte/catholyte temperatures, ARC level, or anolyte/catholyte flow rate or pressure) are out of default range,

(4) full instrumentation to signal sensor failure and/or electrical interrupt,

(5) alarms that signal a problem and/or failure,

(6) instrumentation that put apparatus into safe mode when problems and/or failures occur,

(7) fail-safe protected when apparatus if operated manually,

(8) monitoring of pressures and temperatures are to protect apparatus equipment.

202. (new) The apparatus of claim 178, further comprising inherent safety features includes

- (1) containment vessel with a capacity to hold all the anolyte and catholyte in the apparatus,
- (2) leak detectors that sense a leak and the controller automatically goes into shutdown mode,
- (3) automatically introduce a neutralizing and absorbing materials from the oxidizer suppress injection tank injected into the containment pan based on the sensor detecting electrolyte,
- (4) discharging plates may be in the containment pan to discharge the oxidizer in the electrolyte as soon as the sensor detects presences of electrolyte in the containment pan,
- (5) controller reports the status of the materials disposal through the display monitor and places the system in a standby mode when the disposal is complete,
- (6) hydrogen detectors will initiate a controlled safe shutdown of the MEO apparatus should the hydrogen gas level exceed a safety limit,
- (7) apparatus is segmented by impervious bulkheads to separate auxiliary power systems, gas supply and controller systems from the anolyte and catholyte circulation.

203. (new) The apparatus of claim 178, further comprising an internal power supply providing AC and DC power to the components of the apparatus, external power may be 110 volts AC or higher; internal power supply converts AC to DC and provides a variety of voltage levels throughout the apparatus; a NEMA box may be used to protect from igniting off gases from electrical arcs; electrical compartment may be slightly positive pressurized by air intake and air exhaust fans to not allow off gases to enter the compartment.

204. (new) Apparatus for treating and oxidizing materials comprising new unique electrochemical cell for various embodiments and other appropriate applications, wherein all surfaces in the electrochemical cell that come into contact with the electrolyte, are made of material

selected from the group consisting of polyvinylidene fluoride (PVDF), polypropylene (PP), ethylene-chlorotrifluoroethylene (Halar), polytetrafluoroethylene (PTFE), and combinations thereof, further comprising cell materials selected from the group consisting of fiberglass, polypropylene, metals, composite metals, and combinations thereof, an electrochemical cell comprising a box, a lid, and input and exit tubings through the lid to allow anolyte and/or catholyte to enter and exit respectively through the tubings to and from the electrochemical cell, the box and lid being composed of metal(s) and/or metal composites and the surfaces in contact with the electrolytes are coated with a glass glaze or metallic oxides, wherein separated cell containing the anolyte are connected by anolyte conduits in the wall of the electrochemical cell so that the anolyte solution flows through the entire electrochemical cell and wherein the cell containing the catholyte are connected by catholyte conduits in the wall of the electrochemical cell thereby enabling easy maintenance through ease of access to the interior of the box and to the membranes.

205. (new) The apparatus of claim 204, wherein the electrochemical cell has a molded unibody construction and the lid is coupled to the box, slots in the box for holding frames, wherein the frames receive and hold the membranes in liquid-tight manner to keep the anolyte and catholyte separated, comprising porous electrodes so that electrolyte flows through the electrodes and contacts both sides of the electrodes, a gasket in the lid for creating a tight seal, interior walls in the box for separating the anolyte from the catholyte, electrodes including anodes and cathodes in slots in the ceramic walls and electrical connections to the electrodes passing through the lid to anode bus and cathode bus, walls of the box having ridges and grooves to promote turbulent flow thereby reducing adverse boundary layer related phenomena at the anodes, plurality of electrochemical cells coupled together and having a pier box and lid, nuts and bolts and clamp holes on the box and/or lid for coupling the lid to the box as well as providing easy access to interior of the electrochemical cell significantly improving the maintenance of the electrochemical cell, interior surfaces having PTFE

coating to protect the surfaces from oxidizers in the anolyte and acids or alkaline in the catholyte, glazed inside surfaces of the box and the lid to protect the ceramic walls from the oxidizer in the anolyte solution and the acids or alkaline in the catholyte solution, comprising oxidation resistant ion selective membranes bonded over interior walls serving as ceramic membranes for supplementing performance of the ceramic membranes, wherein some of the interior walls are ion selective semi-permeable membranes.

206. (new) The apparatus of claim 204, further comprising platinum wires and/or miniature ORP electrodes in each chamber of the anolyte and catholyte chambers positioned such that the electrical potential may be measured between the chambers to provide information of the concentration of oxidizer in the anolyte chamber and also as an indicator of any leakage in the membrane, concentration level may be controlled by varying the DC current in the electrochemical cell, oxidizer level may be controlled by diverting some of the anolyte into the discharger and back to the cell.

207. (new) Apparatus for treating and oxidizing materials comprising a fully scalable technology sizable to volume, throughput, and composition of materials to be processed, further comprising materials selected from the group consisting of:  
medical (including medical materials, infectious materials, sharps, pathological materials, sterilization and disinfection); veterinary materials (including animal medical waste, whole research animals); pharmaceutical materials (including out-of-date drugs, rejected drug production, illegal drugs); animal materials (including animal parts, animal excretions, beddings); animals (including laboratory research animals such as mice, rabbits, and large animals such as swine, cows); food materials (including food preparation, unconsumed and partially consumed); solid residential materials (including household trash); solid commercial materials (including paper, plastics); ship materials (including government ships, commercial ships, and private ships and boats); municipal

sewage (including municipal sludge); mortuary materials (including the disposal of body fluids, fluids used in embalming process); halogenated hydrocarbons (includes most of the halogenated hydrocarbons except fluorinated hydrocarbons); military materials (including both organic and inorganic products), transportation (including cleaning and disposing of materials carried in train tank cars, highway tank trucks); landfill materials (including hazardous runoff, hazardous materials); land recover (including brown fields, soil remediation); energetics and pyrotechnics (including explosive materials); herbicides and pesticides (including disposal of herbicides and pesticides, cleaning contaminated equipment); mining (including gold and silver mine tailing, cyanides, and other process); carbon compounds (including incinerator ash); metallurgical industry (including metal plating, metal cleaning); transuranics/actinides (including dissolution of transuranics/actinides, destroying mixed waste); chemical intermediates (including decomposing organic compounds from a higher carbon content to molecules of lesser content to be used as intermediates in other chemical process); paper industry (including the replacement of chlorine in the paper making and recycling process); ozone generation at low voltage (including replacement for bleaching processes, disinfection); absorption of volatile organic carbons (including the use of the MEO apparatus as a scrubber); chlorine process industry (including the replacement of chlorine as a bleach and/or as an oxidizer with an environmentally benign MEO process); chemical fertilizers industry (including the conversion of manures and municipal sludge to inorganic compounds to use as fertilizers); micro-processor industry (including the replacement of hazardous solvents, cleaning and conditioning of printed circuit boards); halogenated inorganic industry (including all halogenated inorganic compounds except those containing fluorine); and hydrogen fuel industry (including the generation of hydrogen for fuel cells, the generation of hydrogen for hydrogen burners for such items as water heaters and furnaces), and combinations thereof.